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(54) **MULTIPLE SEQUENCED ROTATIONAL AIR VALVES FOR VACUUM TRANSPORT**

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(51) **Int. Cl.**
B65H 5/02 (2006.01)

(52) **U.S. Cl.** **271/276**; 271/196; 198/803.5

(58) **Field of Classification Search** 271/276, 271/194, 196, 197, 108; 198/803.5
See application file for complete search history.

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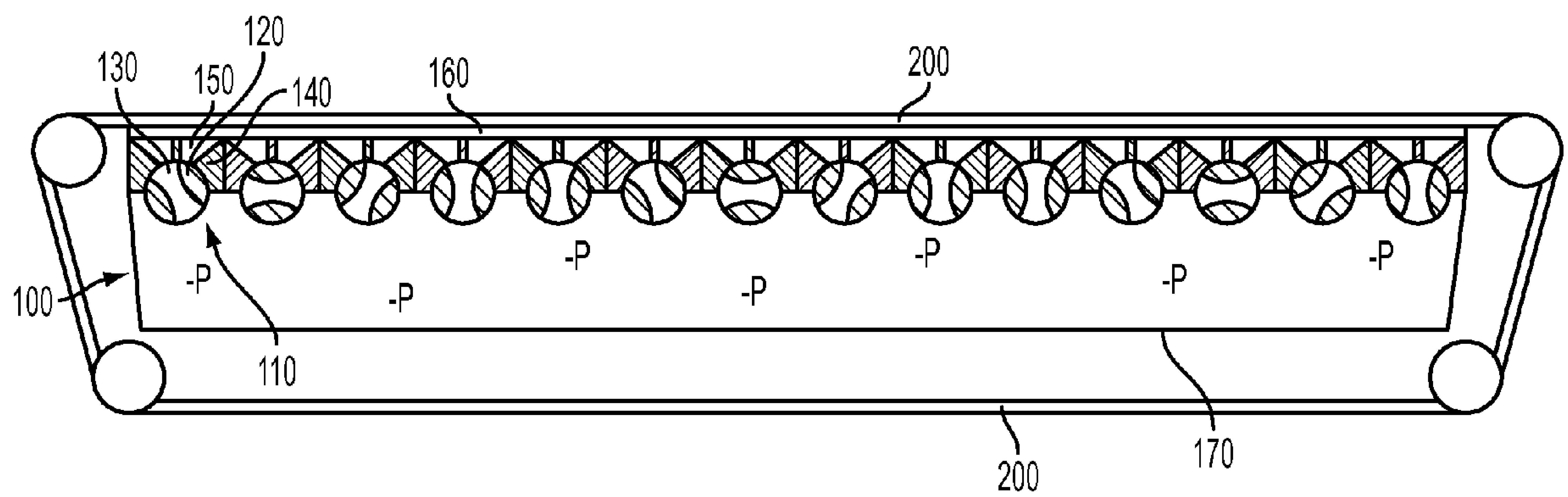
(57) **ABSTRACT**

A vacuum control assembly for use in an image production device is provided. The assembly has a plenum, a perforated plate, a plurality of valve assemblies, and a controller. Each valve assembly has a rotating valve having a vacuum passage, and a chamber body having a plurality of chambers. Each valve is rotatable between a first position that fluidly connects the vacuum passage with at least one of the chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the chambers. The controller controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate.

20 Claims, 4 Drawing Sheets



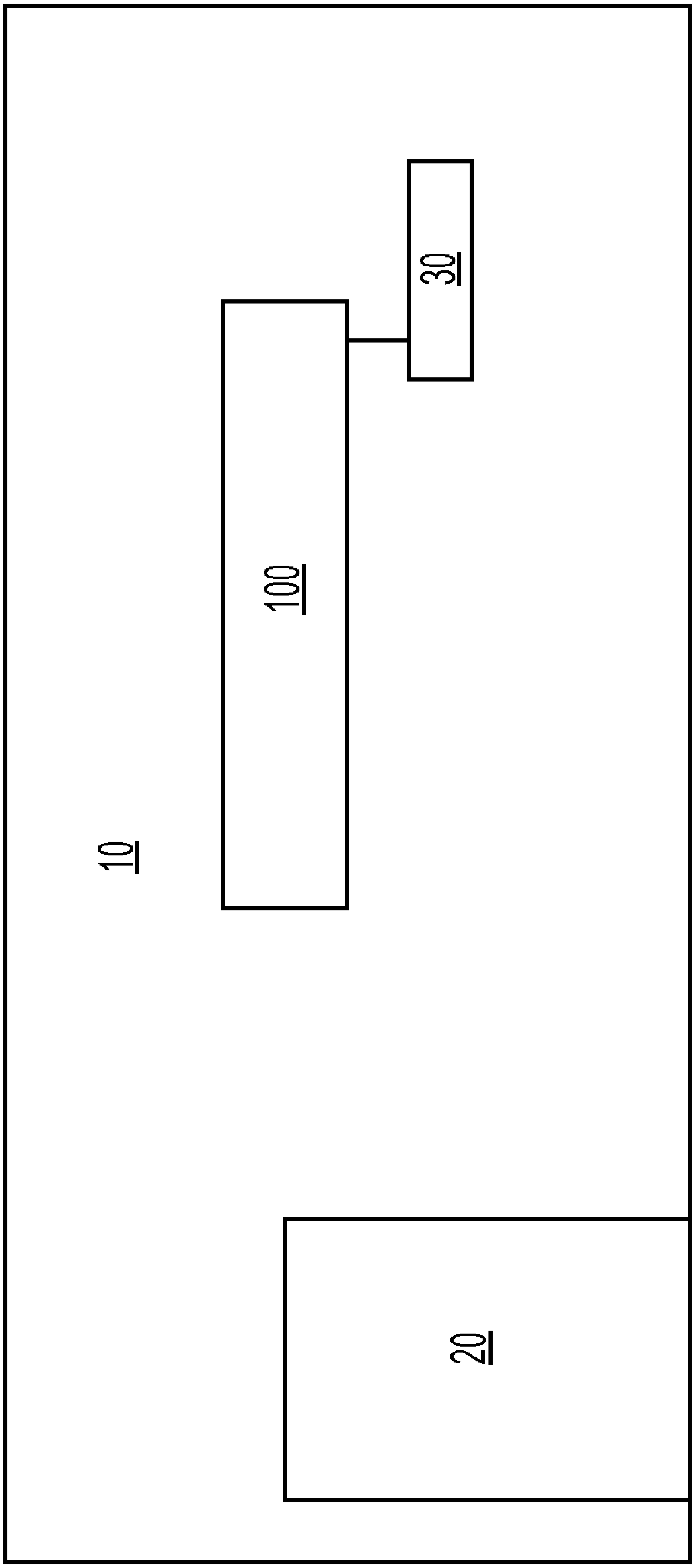


FIG. 1

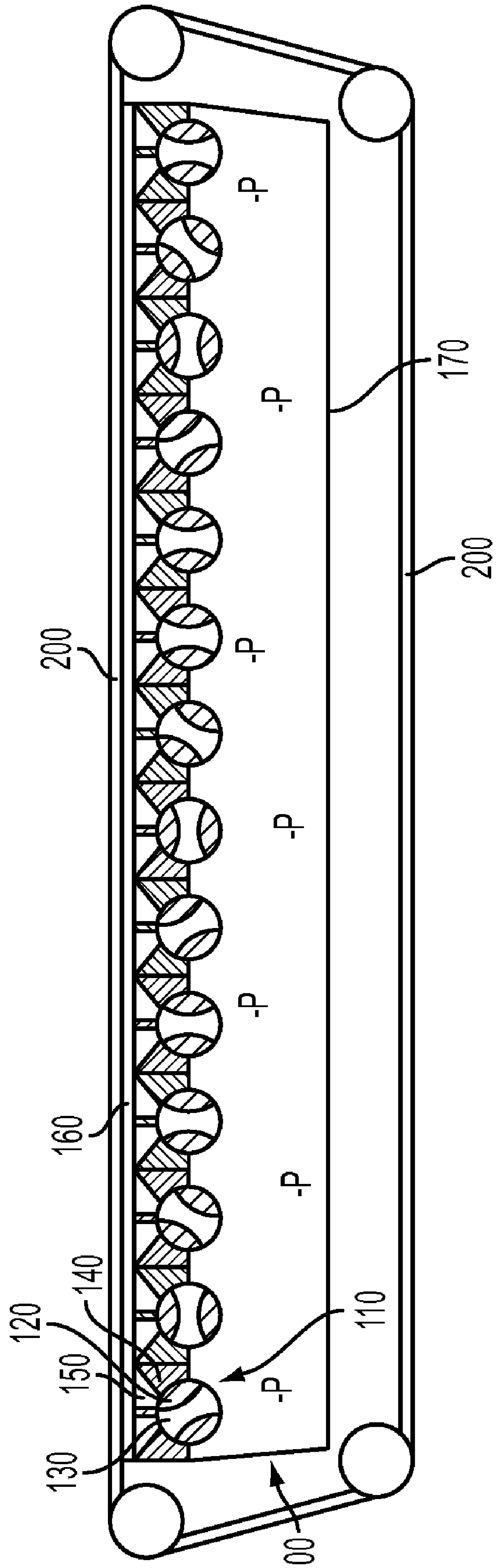


FIG. 2

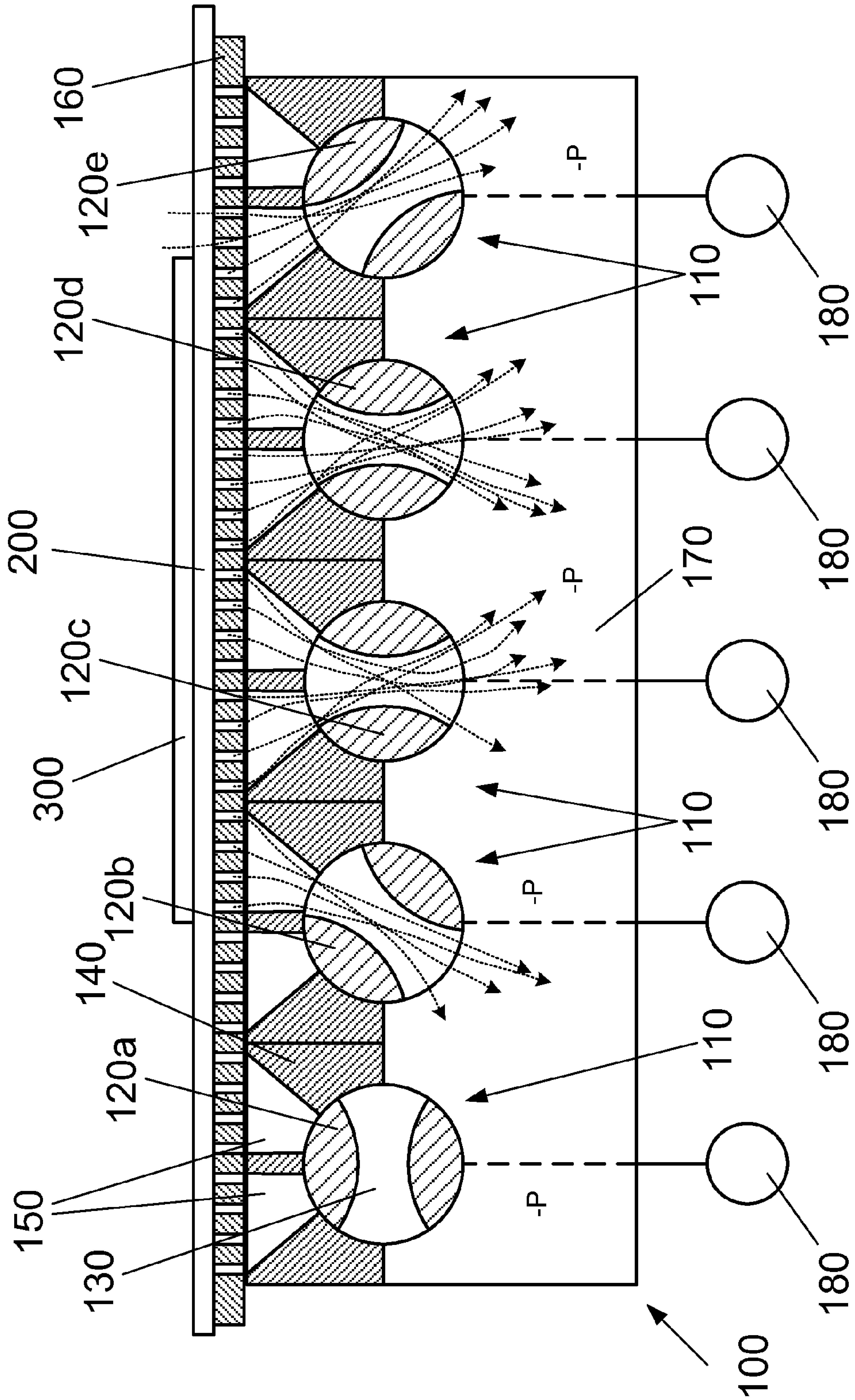

160
120e
120d
200
120c
300
120b
140
120a
150
130
100
110
110
110
170
-P
-P
-P
-P
180
180
180
180
180

FIG. 3

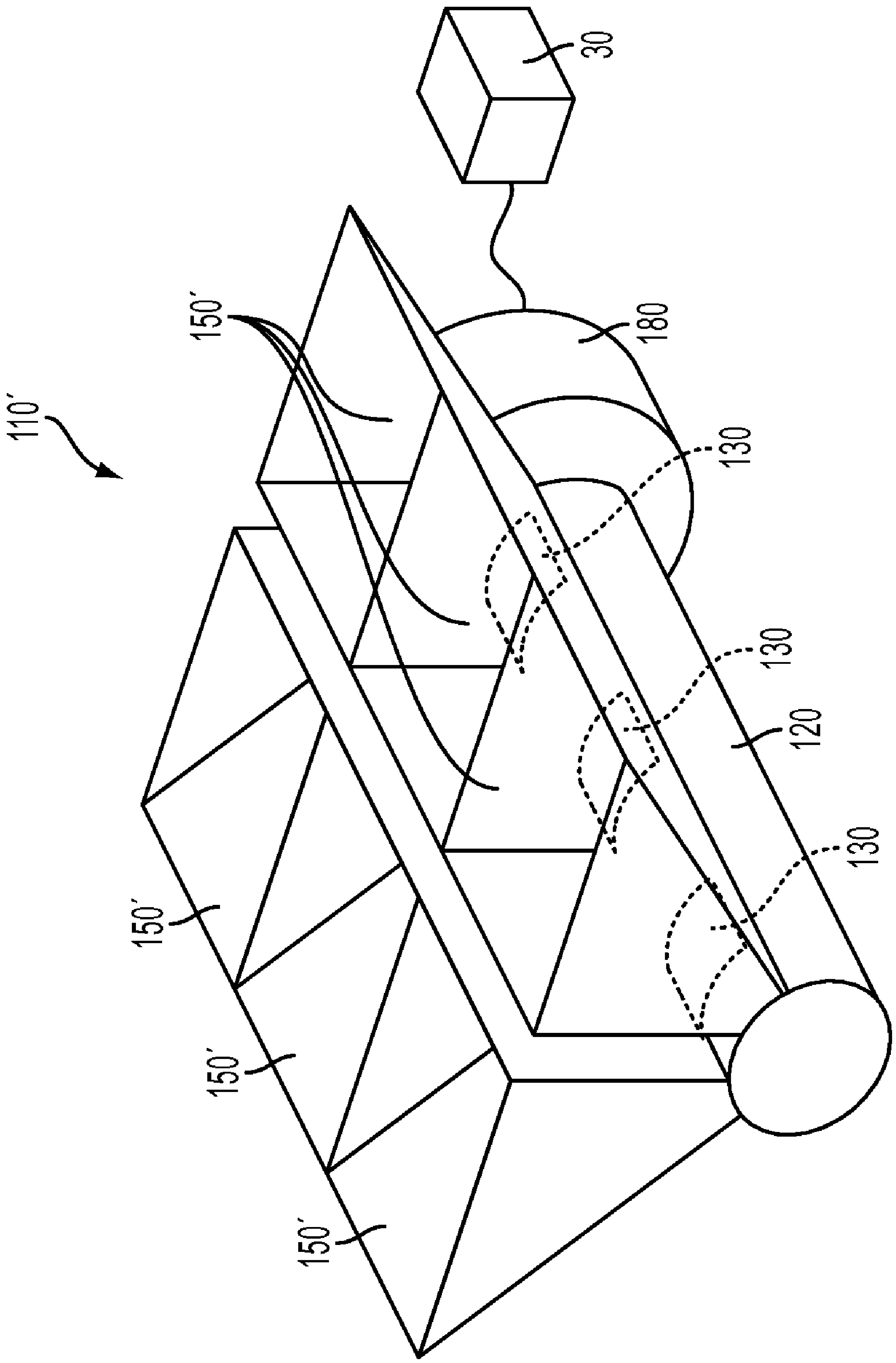


FIG. 4

MULTIPLE SEQUENCED ROTATIONAL AIR VALVES FOR VACUUM TRANSPORT

BACKGROUND

Disclosed herein is a system and method for controlling the application of vacuum in a vacuum transport.

An example of an application for a vacuum transport is an image production device using direct marking print heads. The flatness and motion control requirements for direct marking print heads are extremely demanding. One strategy is to use a vacuum transport belt with ¼" hole spacing over a 28" vacuum plenum. To limit the leakage at the uncovered holes in the process and cross-process directions, the plenum can be divided into a number (for example four) chambers with a separate controllable blower at each chamber. The cost of these blowers is extremely high and there can be a large amount of leakage present. There are also issues related to how a sheet will pass from one chamber to another without losing its suction hold to the belt. In addition, plenum deflection can result, which may require ribbing or other supports to be added.

SUMMARY

A vacuum control assembly for use in an image production device is provided. The assembly has a plenum, a perforated plate, a plurality of valve assemblies, and a controller. Each valve assembly has a rotating valve having a vacuum passage, and a chamber body having a plurality of chambers. Each valve is rotatable between a first position that fluidly connects the vacuum passage with at least one of the chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the chambers. The controller controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of an exemplary image production device in accordance with one possible embodiment of the disclosure;

FIG. **2** is an exemplary diagram of a vacuum transport in accordance with one possible embodiment of the disclosure;

FIG. **3** is an exemplary diagram of a portion of a vacuum transport in accordance with one possible embodiment of the disclosure; and

FIG. **4** is an exemplary perspective view of a portion of a vacuum transport in accordance with one possible embodiment of the disclosure.

DETAILED DESCRIPTION

Aspects of the embodiments disclosed herein relate to a system and method for controlling the application of vacuum in a vacuum transport system.

The disclosed embodiments may include a vacuum control assembly for use in an image production device. The assembly has a plenum, a perforated plate, a plurality of valve assemblies, and a controller. Each valve assembly has a rotating valve having a vacuum passage, and a chamber body having a plurality of chambers. Each valve is rotatable between a first position that fluidly connects the vacuum passage with at least one of the chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the chambers. The controller controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate.

The disclosed embodiments may further include an image production device having a vacuum control assembly, a transport belt for transporting a sheet of medium across a perforated plate, and a media storage compartment for storing sheets of the media. The vacuum control assembly has a plenum, the perforated plate, a plurality of valve assemblies, and a controller. Each valve assembly has a rotating valve having a vacuum passage, and a chamber body having a plurality of chambers. Each valve is rotatable between a first position that fluidly connects the vacuum passage with at least one of the chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the chambers. The controller controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate.

The disclosed embodiments may further include a method of controlling a vacuum transport in an image production device. The method provides a plurality of valve assemblies, each valve assembly having a rotating valve having a vacuum passage, and a chamber body having a plurality of chambers. The method rotates at least one of the valves between a first position that fluidly connects its corresponding vacuum passage with at least one of the chambers in its corresponding chamber body to complete a fluid path between a plenum and a perforated plate, and a second position at which the vacuum passage connects the plenum with none of the chambers. The method controls the rotation of the valves to provide vacuum to a first predetermined portion of the perforated plate while simultaneously preventing the application of vacuum to a second predetermined portion of the perforated plate, and passes a transport belt carrying a sheet of media over the perforated plate.

FIG. **1** is an exemplary schematic diagram of an image production device **10** in accordance with one possible embodiment of the disclosure. The image production device **10** can be any device that is capable of making image production documents (e.g., printed documents, copies, etc.) including a copier, a printer, a facsimile device, and a multi-function device (MFD), for example.

The image production device **10** can include a vacuum control assembly **100**, a media stack **20**, and a controller **30**. Image production device **10** may have other elements that are not shown.

Although the following description is directed toward an image production device, it will be understood that the teachings herein can be applied to any transport system using vacuum.

FIG. **2** is an exemplary diagram of vacuum control assembly **100** positioned inside a transport belt **200**. In this example, transport belt **200** is a perforated belt that is positioned such that it travels adjacent to, and directly above, vacuum control assembly **100**. This example of vacuum control assembly **100** has fourteen valve assemblies **110**. Each valve assembly **110** has a rotating valve **120** positioned in a chamber body **140**. Rotating valve **120** has at least one passage **130**. Chamber body **140** has a plurality of chambers **150** (two in this example). A plenum **170** is located on the side of valve assemblies **110** adjacent to rotating valves **120**. A perforated vacuum plate **160** is positioned on the side of valve assemblies **110** adjacent to chambers **150**.

The use of plenum **170** makes it possible to use only one blower to provide the required vacuum to valve assemblies **110**. Using a plenum also provides uniform vacuum to the valve assemblies, which can be difficult to obtain using multiple blowers.

The operation of vacuum control assembly **100** will be described with reference to FIG. **3**. FIG. **3** shows a portion of vacuum control assembly **100** having only five valve assemblies **110**. A vacuum –P exists in plenum **170** as a result of a blower (not shown) or other vacuum creating device. Each rotating valve **120** is rotated so that its passage **130** is positioned in one of several positions.

Rotating valve **120***a* is positioned so that its passage **130** does not align with any chambers **150**. As a result, the perforations in vacuum plate **160** associated with rotating valve **120***a* are not fluidly connected to plenum **170** and do not see negative pressure –P.

Rotating valve **120***b* is positioned so that its passage **130** aligns with only the right hand side chamber **150** in its chamber body **140**. As a result, only half of the perforations in vacuum plate **160** associated with rotating valve **120***b* are fluidly connected to plenum **170** and see negative pressure –P.

Rotating valve **120***e* is positioned similarly to rotating valve **120***b*, except that its passage **130** aligns with only the left hand side chamber **150** in its chamber body **140**. As a result, only half of the perforations in vacuum plate **160** associated with rotating valve **120***e* are fluidly connected to plenum **170** and see negative pressure –P.

Rotating valve **120***c* is positioned so that its passage **130** aligns with both chambers **150** in its chamber body **140**. As a result, all the perforations in vacuum plate **160** associated with rotating valve **120***c* are fluidly connected to plenum **170** and see negative pressure –P. Rotating valve **120***d* is in a position similar to that of rotating valve **120***c*.

In FIG. **3**, a sheet of paper **300** is held in place on transport belt **200** by negative pressure –P that is communicated through the perforations in vacuum plate **160** by rotating valves **120***b*, **120***c*, **120***d*, and **120***e*. As paper **300** is moved to the right in FIG. **3** by transport belt **200**, the rotating valves will rotate to provide vacuum to only those chambers **150** over which paper **300** is positioned. Leakage can occur at some positions in this process. In FIG. **3** leakage is shown at the right of paper **300** (the leading edge) as a result of rotating valve **120***e*. While this example of the disclosure can allow leakage, far less leakage exists than in conventional vacuum transports. Also, controlled leakage (at the leading edge of the sheet, for example) can be beneficial in keeping the sheet secured to transport belt **200**.

FIG. **4** is a partial perspective view of a valve assembly **110'** in accordance with one possible embodiment of the disclosure. In this example, each chamber is partitioned into three sub chambers **150'**. This example lends itself to controlling leakage in the cross-processing direction. Also shown in FIG. **4** is one possible location of a motor **180** for rotating valve **120**. Controller **30** controls motor **180** to coordinate the rotation of valve **120** with the other valves in the assembly. Each rotating valve **120** can be rotated by a different motor or two or more rotating valves can be rotated by one motor. FIG. **3** shows an exemplary embodiment in which each valve **120** is rotated by a different motor **180**.

The leakage allowed by the vacuum control assembly can be reduced by decreasing the length of the chambers. For example, a vacuum control assembly having a length of 28 inches can have fourteen 2 inch valve assemblies. If each valve assembly has two chambers, each chamber is approximately one inch long. In this example, proper control of the rotating valves results in a maximum leakage of less than two inches. If, however, a 28 inch vacuum control assembly has twenty-eight 1 inch valve assemblies (each having two chambers), each chamber is approximately ½ inch long. As a result, proper control of the rotating valves results in a maximum leakage of less than one inch.

Each chamber body **140** in the example shown in FIG. **3** has two chambers in the process direction. Other examples can use chamber bodies having more or less than two chambers.

Other advantages of possible embodiments of the disclosure are (1) leading edge and trailing edge leakage is easily controlled regardless of paper size and inner document gap, (2) multiple sheets can be handled simply on the transport while maintaining a small amount of leakage, (3) the modular design gives the ability to increase or decrease the length of the vacuum transport as needed for different projects or changes that may occur during the design phase of any given product, (4) the low profile of the vacuum control assembly helps reduce machine space, belt length, and chamber ducting, (5) the chamber bodies can stiffen the top of the plenum, the deflection of which is a concern in conventional systems, (6) the short paths between the plenum and the vacuum plate create near instant suction at the plate when the valves are opened, (7) drag force between the belt and vacuum plate can be reduced by turning off suction in the inner document gap, and (8) drag can be further reduced by turning off the valves that lie under the sheet, keeping only the leading edge and trailing edge valves open at any given time.

It will be appreciated that variations of the above-disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Also that various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A vacuum control assembly for use in an image production device, the assembly comprising:

a plenum;

a perforated plate;

a plurality of valve assemblies, each valve assembly having

a rotating valve member and a vacuum passage passing through the valve member, and

a chamber body having a plurality of chambers, the vacuum passage being capable of simultaneously fluidly connecting the plenum to all chambers of the plurality of chambers,

the valve member being rotatable between a first position that fluidly connects the vacuum passage with at least one chamber of the plurality of chambers but not all chambers of the plurality of chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the plurality of chambers; and

a controller that controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate.

2. The assembly of claim **1**, wherein the valve member is rotatable to a third position that fluidly connects the vacuum passage with all of the chambers of the plurality of chambers in one of the chamber bodies.

3. The assembly of claim **2**, where each valve member is rotated by a separate motor.

4. The assembly of claim **1**, further comprising a motor for rotating the valve members.

5. The assembly of claim **4**, where each valve member is rotated by a separate motor.

6. The assembly of claim **1**, wherein the first predetermined portion of the perforated plate corresponds to a sheet of medium on which an image is to be produced by the image production device.

7. The assembly of claim **1**, wherein each chamber is separated into a plurality of sub-chambers along a direction that is parallel to an axial direction of the valve member.

8. The assembly of claim **1**, wherein the valve assemblies are modular.

9. An image production device, comprising:

a vacuum control assembly having
 a plenum;
 a perforated plate;
 a plurality of valve assemblies, each valve assembly having
  a rotating valve member and a vacuum passage passing through the valve member, and
  a chamber body having a plurality of chambers, the vacuum passage being capable of simultaneously fluidly connecting the plenum to all chambers of the plurality of chambers,
  the valve member being rotatable between a first position that fluidly connects the vacuum passage with at least one chamber of the plurality of chambers but not all chambers of the plurality of chambers to complete a fluid path between the plenum and the perforated plate, and a second position at which the vacuum passage connects the plenum with none of the plurality of chambers; and
 a controller that controls the plurality of valve assemblies to provide vacuum to a first predetermined portion of the perforated plate while also providing no vacuum to a second predetermined portion of the perforated plate;
a transport belt for transporting a sheet of medium across the perforated plate; and
a media storage compartment for storing sheets of the media.

10. The device of claim **9**, wherein the valve member is rotatable to a third position that fluidly connects the vacuum passage with all of the chambers of the plurality of chambers in one of the chamber bodies.

11. The device of claim **10**, where each valve member is rotated by a separate motor.

12. The device of claim **9**, further comprising a motor for rotating the valve members.

13. The device of claim **12**, where each valve member is rotated by a separate motor.

14. The device of claim **9**, wherein the first predetermined portion of the perforated plate corresponds to the sheet of medium.

15. The device of claim **9**, wherein each chamber is separated into a plurality of sub-chambers along a direction that is parallel to an axial direction of the valve member.

16. The assembly of claim **9**, wherein the valve assemblies are modular.

17. A method of controlling a vacuum transport in an image production device, the method comprising:

providing a plurality of valve assemblies, each valve assembly having
 a rotating valve member and a vacuum passage passing through the valve member, and
 a chamber body having a plurality of chambers, the vacuum passage being capable of simultaneously fluidly connecting a plenum to all chambers of the plurality of chambers;
rotating at least one of the valve members between a first position that fluidly connects a corresponding vacuum passage with at least one chamber of the plurality of chambers but not all chambers of the plurality of chambers in a corresponding chamber body to complete a fluid path between the plenum and a perforated plate, and a second position at which the vacuum passage connects the plenum with none of the plurality of chambers;
controlling the rotation of the valve members to provide vacuum to a first predetermined portion of the perforated plate while simultaneously preventing the application of vacuum to a second predetermined portion of the perforated plate; and
passing a transport belt carrying a sheet of media over the perforated plate.

18. The method of claim **17**, further comprising:

rotating at least one of the valve members to a third position that fluidly connects a corresponding vacuum passage with all of the chambers of the plurality of chambers in a corresponding chamber body.

19. The method of claim **18**, wherein each valve member is rotated by a separate motor.

20. The method of claim **17**, wherein the valve assemblies are provided in a modular form.

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